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PATENT COOPERATION TREATY

PCT

REC'D 15 SEP 2000
WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
15245 LgCm		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB99/01912	16/06/1999	24/06/1998

International Patent Classification (IPC) or national classification and IPC
F01N3/08

Applicant
AEA TECHNOLOGY PLC et al.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29/11/1999	12.09.2000
Name and mailing address of the international preliminary examining authority:	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Zebst, M Telephone No. +49 89 2399 7313

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/01912

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

3-9	as originally filed			
1,2,2a	as received on	22/08/2000	with letter of	17/08/2000

Claims, No.:

1-19	as received on	22/08/2000	with letter of	17/08/2000

Drawings, sheets:

1/4-4/4	as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive st p or industrial applicability; citations and explanations supporting such stat m nt

1. Statement

Novelty (N)	Yes:	Claims 1-11
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-11
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-11
	No:	Claims

2. Citations and explanations

see separate sheet

R Item V

1. The industrial applicability of the invention seems to be self-evident (Article 33(4) PCT).

2. Reference is made to the following documents:

   D1:EP-A-0608619

   The document D1 was not cited in the international search report. A copy of the document is appended hereto.

3. Claim **1**

3.1. Novelty

The document D1 is regarded as being the closest prior art to the subject-matter of claim **1**, and shows (the references in parentheses applying to this document):

> *a **reactor** for the treatment of a gaseous medium* (column 1, lines 48-57),
> *including a cylindrical reactor chamber (201,202) having an inlet port (213) and an outlet port for a gaseous medium to be processed* (figure 2),
> *a hollow cylindrical gas permeable bed (208) contained within the reactor chamber (201) and substantially co-axial therewith* (column 4, lines 15-19),
> *the gas permeable bed comprising a catalytically active material for interacting with the gaseous medium to promote chemical reaction therein* (column 4, lines 19-41; figure 2),
> *an annular space between the outside of the bed of active material (210) and the inside of the reactor chamber (202) and means (202,203,204,210) for constraining the gaseous medium to enter the said annular space at one end in an axial direction, the other end of said annular space being closed (204) to axial flow of gaseous medium therefrom, the gaseous medium passing radially through the bed (208) of active material*
> (column 4, lines 5-15; figure 2)

The subject-matter of claim **1** therefore differs from this known reactor according to document D1 in that "*the said annular space is configured to provide an impedance to the flow of the gaseous medium which increases along the length of the said annular space in the direction from the said one end towards the said other end*".

The subject-matter of claim **1** is therefore novel (Article 33(2) PCT).

3.2. Inventive step

As no document of the search report, excluding those related to air filters made of paper material (see for instance US-A-5766289), which operates in a complete other field in the area of engine technology, shows us a reactor which progressively increases the resistance of the axial flow, by progressively reducing the cross-sectional area of the annular space between the outside and the bed of active material and the inside of the reactor chamber, the skilled man finds no teaching in these documents, which would lead him to the invention.

The subject-matter of claim **1** therefore involves an inventive step (Article 33(3) PCT).

4. Dependent claims

Claims **1** to **11** are dependent on claim **1** and as such also meet the requirements of the PCT with respect to novelty and inventive step.

09/701969
Rec'd PCT/PTO 06 DEC 2000
PCT/GB99/01912

The Optimisation of Gas Flow in Reactors for the Treatment of Gaseous Media

The present invention relates to reactors for the treatment of gaseous media and, more specifically to reactors for the removal of noxious substances from the exhaust gases from internal combustion engines.

One type of reactor for the treatment of gaseous media consists of a cylindrical reactor chamber which has inlet and outlet ports by means of which it can be connected into a gas flow system. Inside the reactor chamber, and co-axial within it, is a hollow cylindrical gas permeable bed of active material. The bed of active material is held in place by two supporting disks made of an impermeable material. One support disk has a ring of axially directed holes around its periphery and the other disk has a central hole the diameter of which is approximately equal to the inside diameter of the cylindrical bed of active material. In use a gaseous medium to be processed is admitted to the reactor chamber via the port closer to the first support disk. The gaseous medium is then directed into the annular space between the outside of the cylindrical bed of active material and the wall of the reactor chamber. The closure of this space by the other support disk constrains the gaseous medium to pass radially through the bed of activate material prior to leaving the reactor via the central electrode. The support disks are made of a temperature resistant insulating material and there is provided an electrical connection to the inner electrode by means of which a potential of some kilovolts can be applied to the inner electrode so as to establish a plasma discharge in the gaseous medium in the interstices in the gas permeable bed of active material.

In practice, it has been found that the gas flow distribution through the bed of active material of such a reactor is uneven, being greater at the downstream end of the bed of active material. Thus the reactor may not operate at its maximum efficiency because the upstream end of the bed of active material may be underused while the downstream end of the bed of active material may be subjected to a higher rate of gas flow than it can usefully process.

It is an object of the present invention to provide an improved reactor of the type described above for the processing of a gaseous medium.

According to the preset invention there is provided a reactor for the treatment of a gaseous medium, including a cylindrical reactor chamber having an inlet port and an outlet port for a gaseous medium to be processed, a hollow cylindrical gas permeable bed of an active material contained within the reactor chamber and substantially co-axial therewith, an annular space between the outside of the bed of active material and the inside of the reactor chamber and means for constraining the gaseous medium to enter the said annular space at one end in an axial direction, the other end of said annular space being closed to axial flow of gaseous medium therefrom, the gaseous medium passing radially through the bed of active material, wherein the said annular space is configured to provide an impedance to the flow of the gaseous medium which increases along the length of the said annular space in the direction from the said one end towards the said other end.

The increasing impedance to the axial flow of the gaseous medium through the said annular space preferably is provided by progressively reducing the cross-sectional

Claims

1. A reactor for the treatment of a gaseous medium, including a cylindrical reactor chamber (300) having an inlet port (301) and an outlet port (302) for a gaseous medium to be processed, a hollow cylindrical gas permeable bed (300) of an active material contained within the reactor chamber (300) and substantially co-axial therewith, an annular space (311) between the outside of the bed of active material (303) and the inside of the reactor chamber (300) and means (306) for constraining the gaseous medium to enter the said annular space (311) at one end in an axial direction, the other end of said annular space (311) being closed to axial flow of gaseous medium therefrom, the gaseous medium passing radially through the bed (303) of active material, characterised in that the said annular space (311) is configured to provide an impedance to the flow of the gaseous medium which increases along the length of the said annular space (311) in the direction from the said one end towards the said other end.

2. A reactor according to claim 1, further characterised in that the width of the said annular space (311) decreases continuously along the length of the said annular space (311).

3. A reactor according to claim 1, further characterised in that there is at least one discontinuous decrease in the width of the said annular space (311) along the length of the said annular space (311).

4. A reactor according to claim 3, further characterised in that there is a single discontinuous decrease in the width of the said annular space (311)

approximately at the middle of the said annular space (311).

5. A reactor according to claim 3, further characterised in that there are two discontinuous decreases in the width of the said annular space (311).

6. A reactor according to claim 5, further characterised in that the first discontinuous decrease in the width of the said annular space (311) occurs approximately at the middle of the said annular space (311) and the second discontinuous decrease in the width of the annular space (311) occurs approximately three quarters along the length of the said annular space (311).

7. A reactor according to claim 5, further characterised in that the second discontinuous decrease in the width of the said annular space (311) is less than the first discontinuous decrease in the width of the said annular space (311).

8. A reactor according to claim 1, further characterised in that a first portion of the reactor chamber (300) is provided with at least one axially extending expansion chamber (901).

9. A reactor according to any preceding claim, further characterised in that the bed (303) of active material is contained between two co-axial gas permeable electrodes (304, 305) and two unpermeable transverse insulating supports (306, 307), the transverse support (306) nearer the inlet port (301) to the reactor has a plurality of axially directed gas flow passages (308) disposed around its periphery, the transverse support (307) nearer the outlet port (302) of the reactor has a central hole (309)

the diameter of which is approximately equal to the diameter of the inner co-axial electrode (304) and there is provided means for applying to the inner electrode (304) a potential sufficient to excite and maintain a plasma in a gaseous medium passing through the bed (303) of active material.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 99/01912

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F01N3/08 B01J19/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 766 289 A (HAGGARD CLIFFORD D) 16 June 1998 (1998-06-16) column 2, line 45 -column 3, line 10 column 5, line 63 -column 6, line 54 figures 5-7	1,2,8
X Y	US 4 390 354 A (WITCHELL STANLEY P) 28 June 1983 (1983-06-28) column 1, line 64 -column 3, line 31 figure 1	1,2 3,9
Y A	US 4 419 113 A (SMITH RICHARD H) 6 December 1983 (1983-12-06) column 2, line 15 -column 6, line 23 figures 1,2	3 1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 September 1999	28/09/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Ingegneri, M

1

Form PCT/ISA/210 (second sheet) (July 1992)

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5766289 A	16-06-1998	US 5632793 A	27-05-1997
		US 5632792 A	27-05-1997
		US 5902365 A	11-05-1999
		AU 701994 B	11-02-1999
		AU 6779196 A	12-03-1997
		CA 2233883 A	27-02-1997
		EP 0844904 A	03-06-1998
		WO 9706873 A	27-02-1997
US 4390354 A	28-06-1983	NONE	
US 4419113 A	06-12-1983	GB 2123313 A,B	01-02-1984
US 4954320 A	04-09-1990	AU 4847690 A	08-04-1991
		CA 2021692 A	01-03-1991
		DK 78191 A	27-06-1991
		WO 9103315 A	21-03-1991
		CA 1335806 A	06-06-1995
WO 9912638 A	18-03-1999	GB 2332379 A	23-06-1999
		AU 8872998 A	29-03-1999
		WO 9932213 A	01-07-1999
		WO 9932214 A	01-07-1999

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 954 320 A (BIRMINGHAM JOSEPH G ET AL) 4 September 1990 (1990-09-04) column 2, line 23 -column 3, line 68 column 4, line 42 -column 5, line 50 figure 1 ---	9
P,A	WO 99 12638 A (HALL STEPHEN IVOR ;MARTIN ANTHONY ROBERT (GB); MORGAN ROSS ALEXAND) 18 March 1999 (1999-03-18) page 14, line 2 - line 25 page 19, line 22 -page 20, line 20 figures 1,4 -----	9

TENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
15245 LgCm		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 99/ 01912	16/06/1999	24/06/1998
Applicant		
AEG TECHNOLOGY PLC et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 5

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of th first sheet)

A reactor for the processing of a gaseous medium including a cylindrical reactor chamber (300) within which there is a hollow cylindrical bed of active material (303), and the annular space (311) between the outside (305) of the bed of active material and the reactor chamber (300) is arranged to provide an impedance to axial gas flow which increases in the direction of gas flow along the said annular spaces.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 26 January 2000 (26.01.00)	
International application No. PCT/GB99/01912	**Applicant's or agent's file reference** 15245 LgCm
International filing date (day/month/year) 16 June 1999 (16.06.99)	**Priority date** (day/month/year) 24 June 1998 (24.06.98)
Applicant NG, Ka, Lok et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

29 November 1999 (29.11.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Olivia RANAIVOJAONA

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